



MISSOURI PREGNANCY-ASSOCIATED MORTALITY REVIEW

2017 Annual Report



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Dedication

The Missouri Department of Health and Senior Services (MDHSS) and the Pregnancy Associated Mortality Review (PAMR) board would like to convey our deepest sympathies to the children, partners, parents, and all those who love and miss the 60 women who died while pregnant, or within one year of pregnancy in 2017. We dedicate this report in their memory, in the hope that our efforts to understand the causes and contributing factors of maternal mortality in the state of Missouri will prevent others from experiencing such a loss.



The MDHSS and the PAMR board would like to honor the life of Judy Wilson-Griffin by additionally dedicating this report to her memory. Judy was a member of Missouri's PAMR board since its inception. Her dedication and commitment to the health of women in the state of Missouri has been greatly appreciated. May her drive and passion continue in the hands of others throughout the state and be an example of exceptional leadership.

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Executive Summary

Maternal mortality events, those where a mother dies during or shortly after pregnancy, are internationally viewed as an indicator that may be used to judge the overall health of a country, state, or community. This report describes the state of maternal mortality in Missouri based on deaths that occurred in 2017. The MDHSS identified deaths of Missouri residents that occurred when a woman was pregnant or within one year postpartum, and referred information regarding the pregnancy and death to the PAMR board. The PAMR board performed a comprehensive review of these deaths. The board's findings and recommendations are summarized in this report, with the goal to prevent future instances of maternal mortality. Below are key findings and recommendations from the PAMR board.

Key Findings

- Sixty-eight percent of verified deaths were pregnancy-associated* for a rate of 56 per 100,000 deaths.
- The pregnancy-related mortality ratio (PRMR) in Missouri was 26 deaths per 100,000 live births.
- The rate of pregnancy-associated Black deaths was more than 4 times greater than the rate of White deaths.
- Eighty percent of pregnancy-related deaths were determined to be preventable.
- A majority (57%) of verified deaths occurred between 43 days and one year after pregnancy.
- The leading cause of injury-related, verified deaths were motor vehicle crashes (MVC) (41%), followed by overdoses/poisonings (33%).
- Substance use disorder (SUD) contributed to 44% of pregnancy-associated and 16% of pregnancy-related deaths.
- Cardiomyopathy was the leading underlying cause of pregnancy-related deaths (26%).
- Mental health conditions contributed to 27% of pregnancy-associated and 16% of pregnancy-related deaths.
- The rate of pregnancy-associated deaths for women on Medicaid was more than 5 times greater than the rate for those with private insurance.

Key Recommendations

After reviewing cases, the PAMR board proposed changes at the patient, provider, facility, community, and/or systems level that could potentially prevent similar deaths in the future.

* For purposes of this report, pregnancy-associated deaths are defined as the death of a woman within one year postpartum that are not a direct result of the pregnancy. Pregnancy-related deaths are directly attributable to a woman's pregnancy.

Recommendations developed by the board are summarized below, and discussed in greater detail within the body of this report.

- Standardize practices and procedures across the healthcare system through utilization of evidence-based practices such as AIM bundles.
- Health care systems should increase continuity of care for women in regards to referrals, follow up care, communication, social determinants of health, transfer of care, etc., during pregnancy and the postpartum period.
- All providers should perform validated depression/anxiety (i.e. EPDS, PHQ, et al.) and substance use screenings at multiple intervals throughout pregnancy and the postpartum period, making referrals to mental health providers as appropriate.
- The state should increase public awareness of the importance of seat belt safety during the perinatal period.
- Providers should be further educated regarding screening, referral, and treatment of:
 - Mental health conditions.
 - Substance use disorder.
 - Cardiovascular disorders associated with pregnancy (i.e. cardiomyopathy, hypertension, etc.).
- The state should extend Medicaid coverage to one year postpartum for all conditions (including medical, mental health and substance use disorder), even if the woman did not start treatment prior to delivery, to target women whose condition is exacerbated in the postpartum period.
- Expand community outreach to educate women on preconception health to optimize a woman's health (regarding obesity, tobacco use, chronic medical conditions, etc.) in vulnerable populations to address disparities in health outcomes.



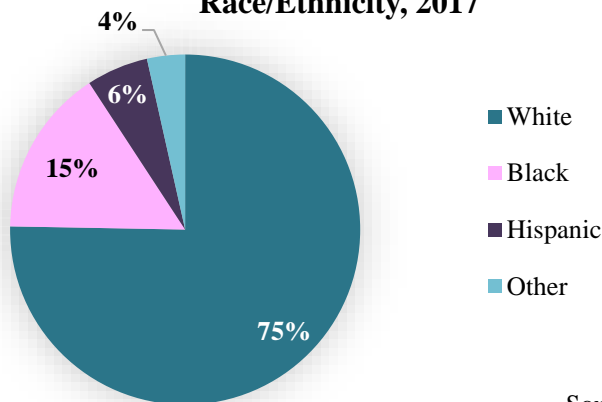
Maternal Health

A woman's health influences the well-being of her children, family, and communities. For the purposes of this report, maternal health is defined as the health of a woman from the time she becomes pregnant until one year postpartum, regardless of the pregnancy outcome. During this time, women may become more engaged with the health care system. For this reason, pregnancy provides an opportunity to identify and manage underlying chronic diseases, such as obesity, hypertension, diabetes, and asthma. The death of a woman during pregnancy, childbirth, or within the first year postpartum is a tragic occurrence that has immediate and lasting influence on her family and communities. These deaths also act as an early warning system for a society's health, reflecting upon a variety of health determinants ranging from individualized factors to more systemic issues.

Maternal Demographics in Missouri

Missouri is a demographically and socially diverse state, comprised of 115 counties (114 counties and one independent city, St. Louis), with a total population of 6,113,532 based on 2017 estimates.¹ Overall, Missouri is a largely rural state, with 16 urban counties and 99 rural counties.² Over half of Missouri's population falls within the Metropolitan Statistical Areas of St. Louis and Kansas City. Most Missouri residents are White[†] (81%) with the majority of the remainder being Black (12%).³

Figure 1: Percent of MO Live Births by Race/Ethnicity, 2017



Source:
DHSS-MOPHIMS-Birth MICA

White women comprised 75% of live births in Missouri during 2017. Black women comprised 15% of live births, and Hispanic women of any race comprised 6% of live births. Women who did not fall into any of the above categories, including Asian, American Indian, Pacific Islander, and other groups, made up 4% of live births (Fig. 1).⁴ There were no substantial differences between the live birth and the women of childbearing age (defined as 12-55 years old) populations.

Statewide Challenges

The data in this report illustrate a number of challenges that are likely to influence maternal morbidity and mortality trends in Missouri. One known challenge is a low rate of timely initiation of prenatal care. Between 2014 and 2018, more than one in four (27%) new Missouri mothers did not begin prenatal care in the first trimester. Among Black women, these rates are significantly higher as two in five (40%) experienced late entry into prenatal care. Untimely initiation of prenatal care is particularly important because prenatal care utilization provides medical professionals with an opportunity for early identification and potential intervention regarding risk factors that affect maternal mortality. This includes the chance to address chronic disease challenges such as obesity, which disproportionately affects Black women (35%, compared to 26% among White women).⁵

Another challenge facing Missouri mothers is limited availability of maternity leave. Missouri state law does not require employers offer paid or unpaid leave to pregnant women other than

[†] Those cases that indicated Hispanic ethnicity were treated as Hispanic, regardless of other race indicators.

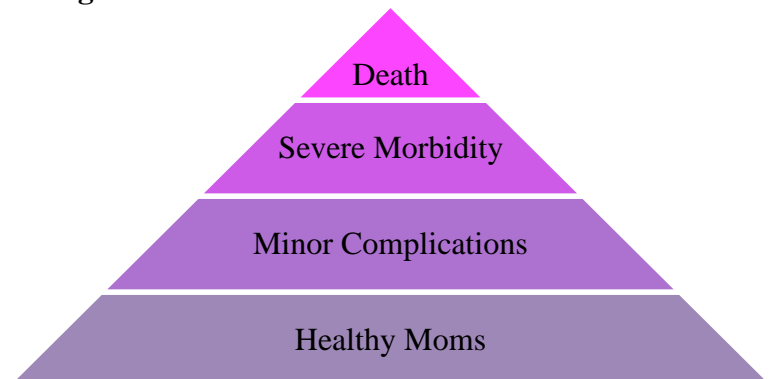
what is required by the Family Medical Leave Act (FMLA), and fewer than half of private sector workers are eligible for FMLA.⁶ Without paid maternity leave, women must make choices between earning a paycheck and proper postpartum recovery. This potentially increases the chance of adverse short- or long-term outcomes related to both mental and physical postpartum health concerns. Fewer than one in three (30%) White mothers received paid maternity leave, and only one in five (20%) Black mothers received paid maternity leave.⁷

Maternal health experiences also differ between rural and urban counties. Regardless of race, women residing in rural counties are nearly twice as likely to smoke while pregnant (20% vs 11%).⁸ They are also likely to be older, and experience challenges obtaining level-appropriate care for complex or high-risk births at rural hospitals.⁹ From 2014-2018, 68% of high-risk births to rural-county residents were at Level III facilities compared with 88% of high risk births to urban-county residents.¹⁰ Some of these rural/urban disparities are exacerbated by race, as rural White mothers (69%) were more likely than rural Black mothers (55%) to receive level-appropriate care.

Maternal Morbidity and Mortality

Pregnancy health outcomes exist on a continuum ranging from healthy moms with no complications, to maternal death. The largest group of women on the continuum are healthy mothers who have a normal outcome with no complications. In general, the more severe the outcome, the less frequently it occurs (Fig. 2). Maternal morbidity, including Severe Maternal Morbidity (SMM) is an overarching term for unexpected outcomes of labor and delivery. These are acute conditions that may directly cause maternal deaths and/or have a significant impact on a woman's short- or long-term health, and may include blood transfusions, renal failures, and hysterectomies.¹¹

Figure 2: Maternal Health Outcome Continuum



- In 2017, there were 772 instances of SMM in the state of Missouri for an overall rate of 111 per 10,000 live births.
- Those most at risk for SMM are women over the age of 35, who are either obese or had other preexisting chronic conditions, or had a prior cesarean delivery.
- White mothers experienced SMM at a rate of 92 per 10,000 live births, while Black mothers experienced SMM at a rate of 213 per 10,000 live births.¹²

The most severe outcome is death during or after pregnancy. This report is focused on these most extreme outcomes, and seeks to accent opportunities to improve maternal health and health care. While maternal mortality continues to decline globally, the rate of maternal mortality in the United States is three to four times higher than in other developed nations. It is estimated that approximately 700 women in the United States die as a result of pregnancy or pregnancy-related complications annually.¹³

Surveillance of Maternal Mortality

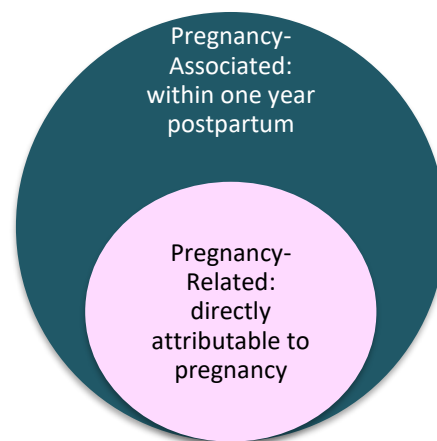
The increasing rate of maternal mortality, and the disparities in those rates, has led to an increased interest in these topics. Reducing maternal mortality and improving maternal health are both state and national priorities. To this end, the State of Missouri has been awarded the Enhancing Reviews and Surveillance to Eliminate Maternal Mortality (ERASE-MM) grant from the Centers for Disease Control and Prevention (CDC). Funding from ERASE-MM supports the PAMR program by facilitating timely identification of deaths, the formation of prevention strategies, and implementation of strategies to reduce maternal deaths and associated disparities.

There are a number of operational definitions for maternal mortality. Missouri PAMR defines a maternal mortality event as a pregnancy-associated death when a Missouri resident dies while pregnant, during delivery, or within one year postpartum. A pregnancy-related death is a subset of pregnancy-associated deaths (Fig. 3), which are defined as the death of a woman while pregnant or within one year of the end of a pregnancy – regardless of the outcome, duration or site of the pregnancy – from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes. For the purposes of this report, deaths which are reported as pregnancy-associated are only those which are not pregnancy-related. Studying these sentinel events highlights critical issues in women’s health, and is crucial for identifying opportunities for improvement.

Distinguishing PAMR

The CDC oversees multiple programs that seek to monitor maternal mortality. These programs offer valuable information at the national level regarding causes of death and associated risk factors. However, they are not able to evaluate contextual factors that contributed to individual

Figure 3: Maternal Mortality Distinctions



deaths, or determine preventability. These programs are also limited by an inability to provide recommendations that would prevent future instances of maternal mortality.

The PAMR program differs from these national programs in that it functions as the states' Maternal Mortality Review Committee (MMRC). MMRCs operate using a standardized and comprehensive system to better understand the context and causes surrounding a woman's death. They are able to determine if a death could have been prevented, and can make recommendations to help similar situations have better outcomes.¹⁴ While focused on the prevention of death, MMRCs also act to improve health and wellness throughout the pregnancy cycle. See Appendix A for a breakdown of differences between maternal mortality surveillance programs.

The objective of this report is to describe the state of maternal mortality in Missouri. Information in this report comes from PAMR board findings and recommendations for improvement in health outcomes. These recommendations are informed by a thorough evaluation of cases identified by the Missouri Bureau of Vital Statistics (BEVS) as potential instances of maternal mortality.



PAMR Process

The BEVS worked to identify cases of maternal mortality for investigation by the PAMR program. Once identified, information was gathered on each case. This included medical records, toxicology reports, news articles, social media postings, and other information. This information was used to create a summary of the events that led up to and ended in the decedent's death. The de-identified summary was then given to the multi-disciplinary PAMR board who evaluated the case to determine pregnancy relatedness, as well as the causes and preventability of a death. The PAMR board made recommendations in order to help improve the outcome of similar situations in the future. The PAMR program and partnering organizations are now working on the implementation of these recommendations.

Identification: Issues and Solutions

PAMR coordinated with BEVS to accurately identify eligible pregnancy-associated deaths for review. All death certificates of Missouri residents (including those residents who died out of state) between the ages of 12 and 55 in 2017 were evaluated. Those certificates where the cause of death indicated it was due to pregnancy, or the pregnancy checkbox indicated that the woman was, or had been pregnant within the last year, were flagged for further investigation. In addition, a birth-death linkage was performed. This linkage flagged any death certificates where the decedents name, social security number, or date of birth appeared on a birth certificate or a fetal death report from the preceding year for further investigation.

Case identification presents some concerns regarding false negatives (when a decedent was pregnant within the last year but was not identified) and false positives (when a decedent was not pregnant but was identified). False negative cases primarily come from instances where a woman was pregnant, but death occurred too early in the pregnancy for it to have been known. At present, there is no viable way to detect these instances.

The pregnancy checkbox has greatly aided case identification, but it is the most common source of false positives, in particular for older decedents and Black women.¹⁵ In 2017, there were six women over the age of 50 who had an incorrectly marked pregnancy checkbox.¹⁶ Additionally, reliance on the pregnancy checkbox can yield false negatives as there were 19 records that were corrected when a death certificate was linked to a birth certificate without the checkbox indicating that the decedent had been pregnant. BEVS staff routinely seek verification of the pregnancy status for cases which lack supporting documentation, or are deemed questionable based on age.

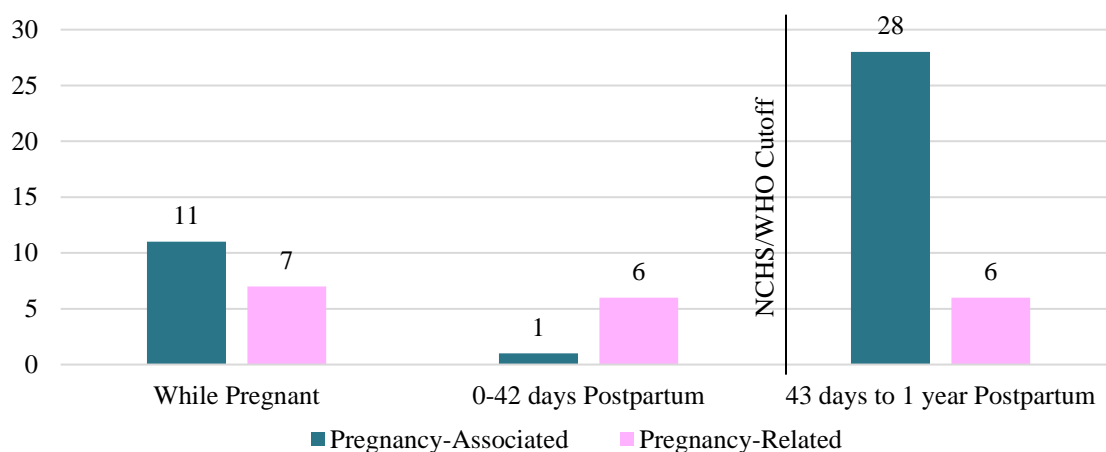
False positives and negatives also occur when the linkage between a death certificate and a birth certificate, or fetal death report, is due to an error in data entry. This is detected during the case verification process and the Bureau of Vital Records (BVR) is alerted to the error and contacts the data provider for correction. For a more detailed breakdown of case identification criteria, see Appendix B.

Identification: Timing and Sources

When a death occurs may influence whether or not it is identified as a case of maternal mortality. As previously discussed, Missouri uses the PAMR standard, which considers a death to be a possible case of maternal mortality if it occurs within one year of the end of pregnancy, regardless of outcome. This aligns with the timeframe utilized by the Pregnancy Mortality Surveillance System (PMSS). However, the definition utilized by the CDC National Center for

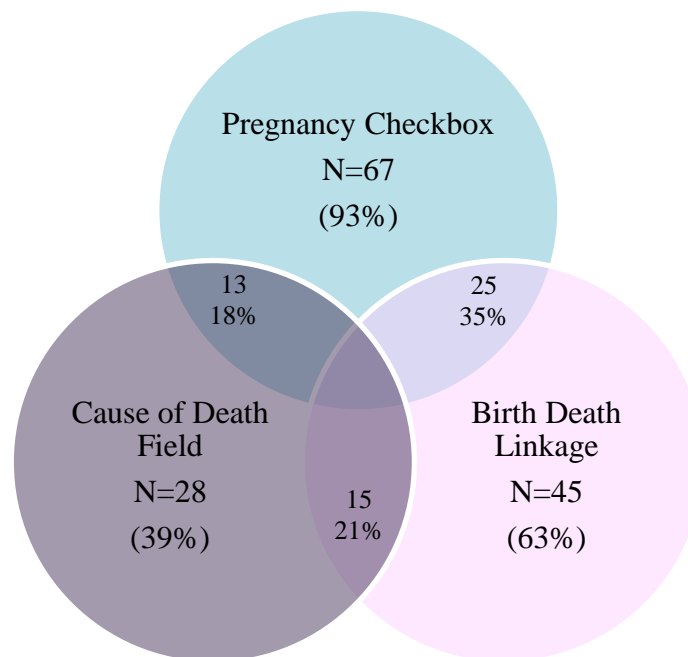
Health Statistics (NCHS) and the World Health Organization (WHO) identifies deaths that occur during pregnancy, or within 42 days postpartum as possible cases of maternal mortality.

Figure 4: Timing of Death by Relationship to Pregnancy, 2017



If traditional NCHS/WHO standards were utilized, 34 cases of maternal mortality would not have been identified or reviewed, six of which the board determined were pregnancy-related (Fig. 4). The NCHS/WHO standard also differs in that it classifies cases as maternal mortality using the ICD-10 codes from death certificates. The PAMR and PMSS standards, use the ICD-10 codes as part of their case identification process; and then evaluate these cases to classify them as pregnancy-associated or pregnancy-related. In 2017, the pregnancy checkbox identified 67 cases. Twenty-eight cases were identified by the ICD-10 codes, and the linkage identified 45 cases. No more than 35% of these identified cases overlap (Fig. 5). NCHS found during this time that reliance upon the pregnancy checkbox alone resulted in over reporting of maternal mortality, particularly for older women.¹⁷

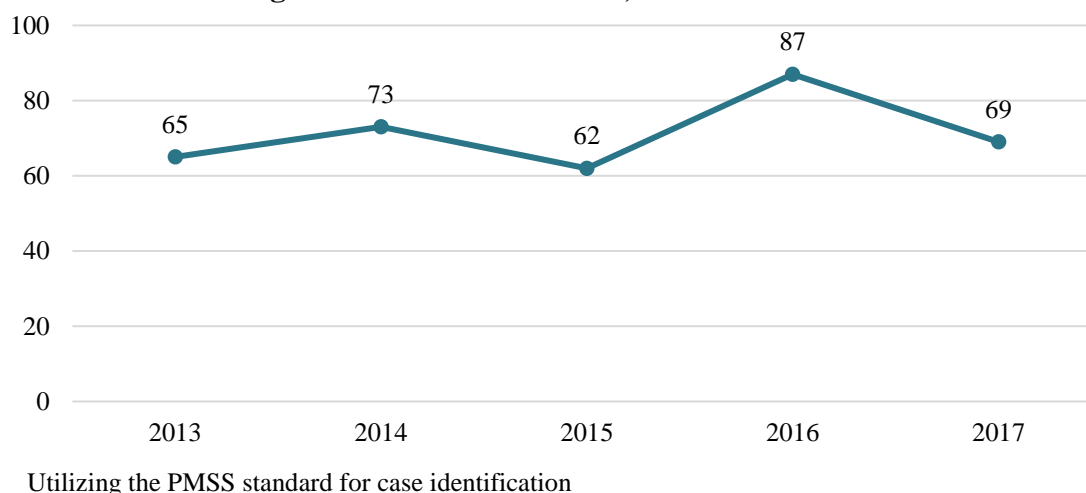
Figure 5: Pregnancy-Associated Death Case Identification



The way which maternal mortality is defined, as discussed, affects the rate. Missouri began using the PAMR standards with the review and analysis of the 2017 data in alignment with the ERASE-MM grant.¹⁸ The difference between the PAMR definition and the PMSS definition is

that PMSS looks at deaths which were recorded in Missouri regardless of residency. However, in order to look at trend data, as in Figure 6, the PMSS standard is the one which must be utilized at this time.

Figure 6: Number of Deaths, Missouri 2013-2017

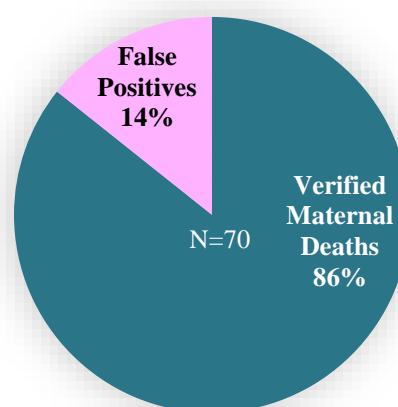


Case Verification

When cases were identified through a linkage, they were further scrutinized prior to sending them to the PAMR abstractor. This involved examining the identified certificates to ensure that the data were indeed a match. At this juncture, those cases which were linked based on data entry errors were detected. For example, if a case was matched based on the social security number, but the names, date of birth, and other information did not match, the case was considered unverified, or a false positive as described above.

Once cases underwent this first round of verification, the cases were forwarded to the PAMR abstractor. The abstractor gathered data from medical records, toxicology, autopsy reports, and an array of other resources in order to accurately capture the events leading up to and including the death of the women identified as potential cases. Through this verification process there were 10 cases identified as false positives (meaning that pregnancy was contraindicated, for example by a

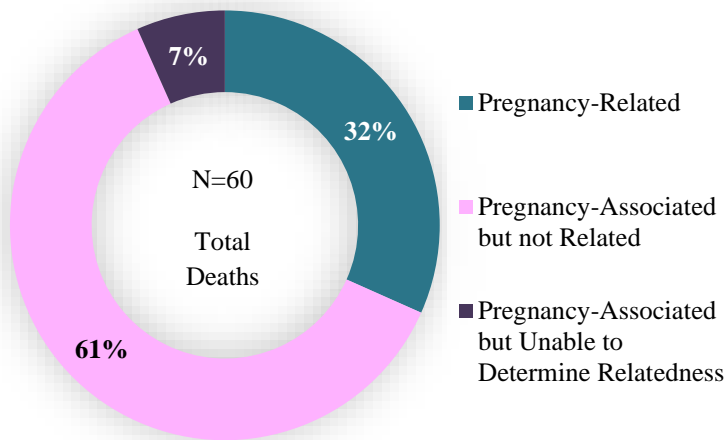
Figure 7: PAMR Case Verification, MO, 2017



previous hysterectomy) to 60 cases that were verified in 2017 (Fig. 7). Then, using the information obtained, the abstractor created a detailed, but de-identified, case summary for each case that retained any indication of pregnancy within the year preceding death. Finally these summaries were routed to the PAMR board for review.

Case Review

Figure 8: Committee Determination of Pregnancy-Related/Associated Deaths, 2017

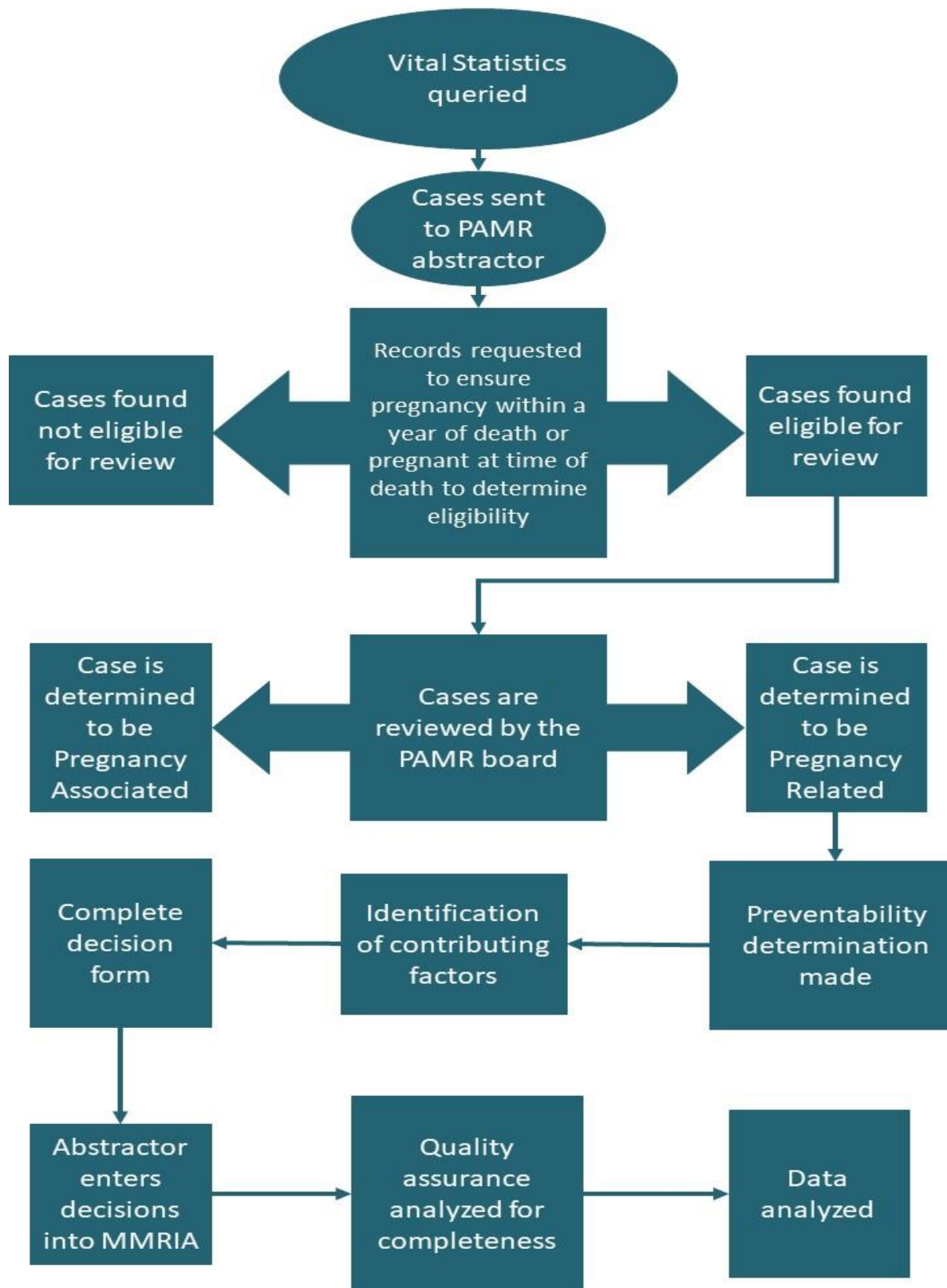


The PAMR board members collaboratively reviewed the case summaries provided by the abstractor. As requested, and as appropriate, additional information was made available beyond the case summaries. While some states divide the caseload by the cause of death, the entire Missouri PAMR board evaluated all verified cases. They worked to determine pregnancy-relatedness, evaluated the cause of death, and provided recommendations for improved outcomes.

- In 2017, 19 cases were determined to be related to pregnancy.
- Thirty-seven cases were found to be associated but not related (Fig. 8).
- A further four cases were determined to be pregnancy-associated but the board was unable to determine relatedness.
 - For the purposes of this report, these are treated as pregnancy-associated cases.

See Figure 9 for a visual overview of the PAMR process.

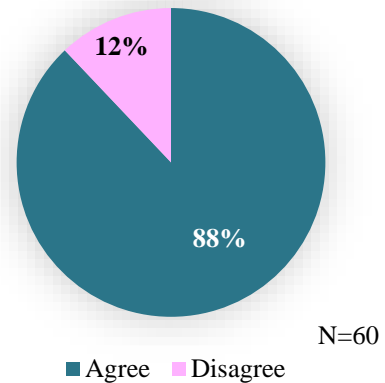
Figure 9: Flow Chart of PAMR Program Process



Data Evaluation

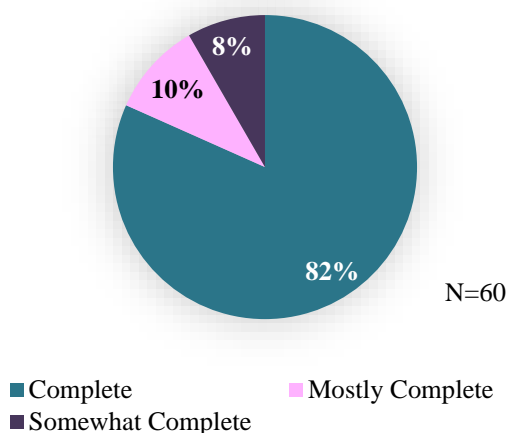
The PAMR board agreed with the underlying cause of death listed on the death certificate the majority of the time (88%, Fig. 10). This is the default approach the PAMR board took, disagreeing with the provided cause of death only when there was sufficient evidence to justify disputing the information found on the death certificate. As with most things, the decisions of the PAMR board were dependent upon the quality of information they received, and their abilities were also limited by that same restriction. For this reason, the PAMR board evaluated every case for completeness, to ensure they were being given data of sufficient quality with which to make their determinations.

Figure 10: Committee Agreement with Underlying Cause of Death Listed on Death Certificate



Regarding 2017 cases, the PAMR board found that the records were complete or mostly complete for 92% of the cases worked, and were somewhat complete for 8% of those cases (Fig. 11). In order to assure the best data quality possible, the PAMR program did attempt to obtain more specific information if the board requested such. Every attempt was made to obtain records from healthcare providers and facilities, as well as coroners and medical examiners. However, toxicology screenings and autopsies were not always performed, and additional information from the healthcare system was not always obtainable. As such, the program occasionally did find itself desiring data that simply did not exist. To combat this issue, the PAMR board

Figure 11: Case Completeness



recommended that autopsies be mandatory for all known instances of maternal death. Case completeness was also complicated because not all relevant information was documented or known. For instance, a woman could have sought medical treatment from a provider in another location and not disclosed that visit at her next healthcare interaction, or the previous provider may not have been able to be identified. Such concerns helped to drive the board's recommendations regarding continuity of care and were connected to recommendations for a centralized electronic medical records system.



PAMR Demographic Disparities

After cases are reviewed by the board, the data gathered is broken down based on demographic factors, including age, race, educational attainment, and marital status. It is further evaluated by place of residence, payment type, and maternal weight. Comparing these rates helps us determine the degree of disparity in health outcomes between each group. Rates of maternal mortality are reported as number of deaths per 100,000 live births.

- The rate of pregnancy-related deaths was over four times higher for those who were more than 40 years old compared to those who were between 20 and 29.
- The rate of Black deaths was more than four times higher than White deaths.
- Those who had obtained more than a high school education had the lowest rates compared with those who had a high school education or less.
- The rate of pregnancy-related deaths for women who were obese was more than 2.5 times greater than for women with an average (or normal) BMI.
- The rate of pregnancy-associated and –related death was roughly five times greater for unmarried women compared to married women.

A Word of Caution

Instances of maternal mortality, and in particular pregnancy-related instances, are rare events. As such, the sample size for this analysis is small. The problem of having a small sample size is there is an increased likelihood of the results being skewed; meaning some effects may be exaggerated, while others may remain hidden. This skewness may be increased when data are missing. Due to these concerns, the rates presented here should be approached carefully. The PAMR board makes their recommendations with this in mind, seeking to not only lower rates of maternal mortality and SMM, but to improve the reproductive health outcomes of women overall.

Missouri Mothers and Disparities

- The average woman giving birth in the state of Missouri in 2017 was a married, White woman between the ages of 20 and 29 who attained more than a high school education, and most frequently had a normal BMI.
- Comparatively, the average woman who experienced a pregnancy-associated death was an unmarried, White woman with a normal BMI, between the ages of 20 and 29 who attained a high school education.
 - The overall rate of pregnancy-associated deaths was 56 deaths per 100,000 live births.
- The average woman who experienced a pregnancy-related death was an unmarried, White woman who was obese between the ages of 20 and 29 with a high school education.
 - The overall rate of pregnancy-related deaths was 26 deaths per 100,000 live births.

Table 1: Maternal Age Comparison of Rates, 2017						
Maternal Age	Pregnancy-Associated Deaths		Pregnancy-Related Deaths		Total Missouri Births	
	Freq.	Rate per 100,000 live births	Freq.	Rate per 100,000 live births	Freq.	%
< 20 years old	‡	92.6 §	‡	0.0 §	4,321	5.9
20 to 29 years old	28	70.6	12	30.3	39,662	54.3
30 to 39 years old	9	32.7	5	18.2	27,511	37.6
40 + years old	‡	0.0 §	‡	132.9 §	1,505	2.1
Unknown	-	-	-	-	18	0.0

‡ Information redacted due to small sample size on Tables 1 through 7.

§ These rates are considered unstable due to low sample size on Tables 1 through 7.

The rate of pregnancy-associated death was highest among women under 20 years old, with a rate of 93 deaths per 100,000 live births. Pregnancy-related deaths were highest among women aged 40 years or older with a rate of 133. The lowest non-zero rates for both pregnancy-associated (33) and -related (18) categories were for women between ages 30 and 39.

Table 2: Maternal Race/Ethnicity Comparison of Rates, 2017						
Maternal Race	Pregnancy-Associated Deaths		Pregnancy-Related Deaths		Total Missouri Births	
	Freq.	Rate per 100,000 live births	Freq.	Rate per 100,000 live births	Freq.	%
White	19	34.7	12	21.9	54,733	75.3
Black	16	142.1	6	53.3	11,258	15.5
Hispanic	‡	48.2 §	‡	24.1 §	4,152	5.7
Other	‡	117.6 §	‡	0.0 §	2,550	3.5

Black women had the highest rate of pregnancy-associated and -related deaths. The rate of pregnancy-associated deaths for Black women (142) was more than four times the rate for White women (35). The rate of pregnancy-related deaths (53) was more than twice the rate of White women (22). The disparity in racial outcomes was statistically significant.**

Table 3: Educational Attainment Comparison of Rates, 2017						
Maternal Education Level	Pregnancy-Associated Deaths		Pregnancy-Related Deaths		Total Missouri Births	
	Freq.	Rate per 100,000 live births	Freq.	Rate per 100,000 live births	Freq.	%
< High School	11	125.6	‡	22.8 §	8,761	12.0
High School	20	110.3	11	60.7	18,132	24.9
More than High School	9	19.6	6	13.1	45,862	63.0

Women who had attained less than a high school diploma or GED had the highest rate of pregnancy-associated death (126). Though not a statistically significant difference due to low sample size, this rate was more than six times the rate of women who attained more than a high school education. The highest rate of pregnancy-related deaths (61) was found among women who had attained a high school education or GED. This rate was more than four times the rate of women who attained more than a high school education.

** Statistical significance was determined at the ($p \leq 0.05$) level using Chi-Square testing.

Table 4: County of Residence Comparison of Rates, 2017						
County of Residence	Pregnancy-Associated Deaths		Pregnancy-Related Deaths		Total Missouri Births	
	Freq.	Rate per 100,000 live births	Freq.	Rate per 100,000 live births	Freq.	%
Urban	19	39.0	10	20.5	48,715	66.7
Rural	8	32.9	‡	16.5 §	24,302	33.3

Though disparities exist between urban and rural women, as discussed earlier, there were no statistically significant differences between the rates for either pregnancy-associated or pregnancy-related deaths.

Table 5: Payment Type Comparison of Rates, 2017						
Payment Type	Pregnancy-Associated Deaths		Pregnancy-Related Deaths		Total Missouri Births	
	Freq.	Rate per 100,000 live births	Freq.	Rate per 100,000 live births	Freq.	%
Private Insurance	5	12.5	‡	10.0 §	40,059	54.9
Medicaid	18	64.5	6	21.5	27,915	38.2
Other/Unknown	‡	39.7 §	‡	39.7 §	5,043	6.9

Women who utilized Medicaid services had the highest rate of pregnancy-associated deaths (65) when compared to other insurance types. This was five times the rate of women who were on private insurance (13). Though not a statistically significant difference due to low sample size, the rate of pregnancy-related deaths among women who utilized Medicaid was over twice the rate of women on private insurance.

Table 6: Maternal BMI Comparison of Rates, 2017						
Maternal Weight	Pregnancy-Associated Deaths		Pregnancy-Related Deaths		Total Missouri Births	
	Freq.	Rate per 100,000 live births	Freq.	Rate per 100,000 live births	Freq.	%
Underweight	‡	36.2 §	‡	0.0 §	2,760	3.8
Normal weight	10	31.8	‡	12.7 §	31,462	43.7
Overweight	7	39.8	‡	5.7 §	17,585	24.4
Obese	9	44.6	7	34.7	20,175	28.0

Body Mass Index (BMI) was calculated based on a woman's pre-pregnancy height and weight. Women who were obese had the highest rate of pregnancy-associated deaths (45). Women who were obese also had the highest rate of pregnancy-related deaths (35). The differences between BMI categories for pregnancy-related deaths was not statistically significant.

Table 7: Marital Status Comparison of Rates, 2017						
Marital Status	Pregnancy-Associated Deaths		Pregnancy-Related Deaths		Total Missouri Births	
	Freq.	Rate per 100,000 live births	Freq.	Rate per 100,000 live births	Freq.	%
Married	6	13.7	‡	6.8 §	43,856	60.1
Not Married	20	68.6	10	34.3	29,161	39.9

Women who were unmarried had the highest rate of pregnancy-associated deaths (69). This rate was five times the rate of married women (14). Women who were unmarried also had the highest rate of pregnancy-related deaths (34). Though not a statistically significant difference due to low sample size, this rate was five times the rate of married women (7).

The PAMR program employed a life course perspective to help better understand the context around a woman's death. Beyond the demographic analyses reported above, it was determined that women whose deaths were pregnancy-related showed evidence of undergoing social and emotional distress. Unemployment impacted 42% of these women, and a history of substance use impacted 32%. More than one in four (26%) of them had a history of domestic violence and 16% had a history of childhood trauma. This expanded perspective aids in the development of recommendations.

Data concerning the statewide challenges is limited regarding prenatal care and maternity leave. Prenatal care information is not presently available for those women who died during pregnancy. However, for those women who had a live birth but experienced a pregnancy-related death, 66% (N=8) did not receive prenatal care during the first trimester in 2017. While currently limited by low sample size, as additional data is gathered further investigation into this challenge may be possible. Presently, the PAMR program does not have sufficient data to address the challenge of limited maternity leave in the state of Missouri.



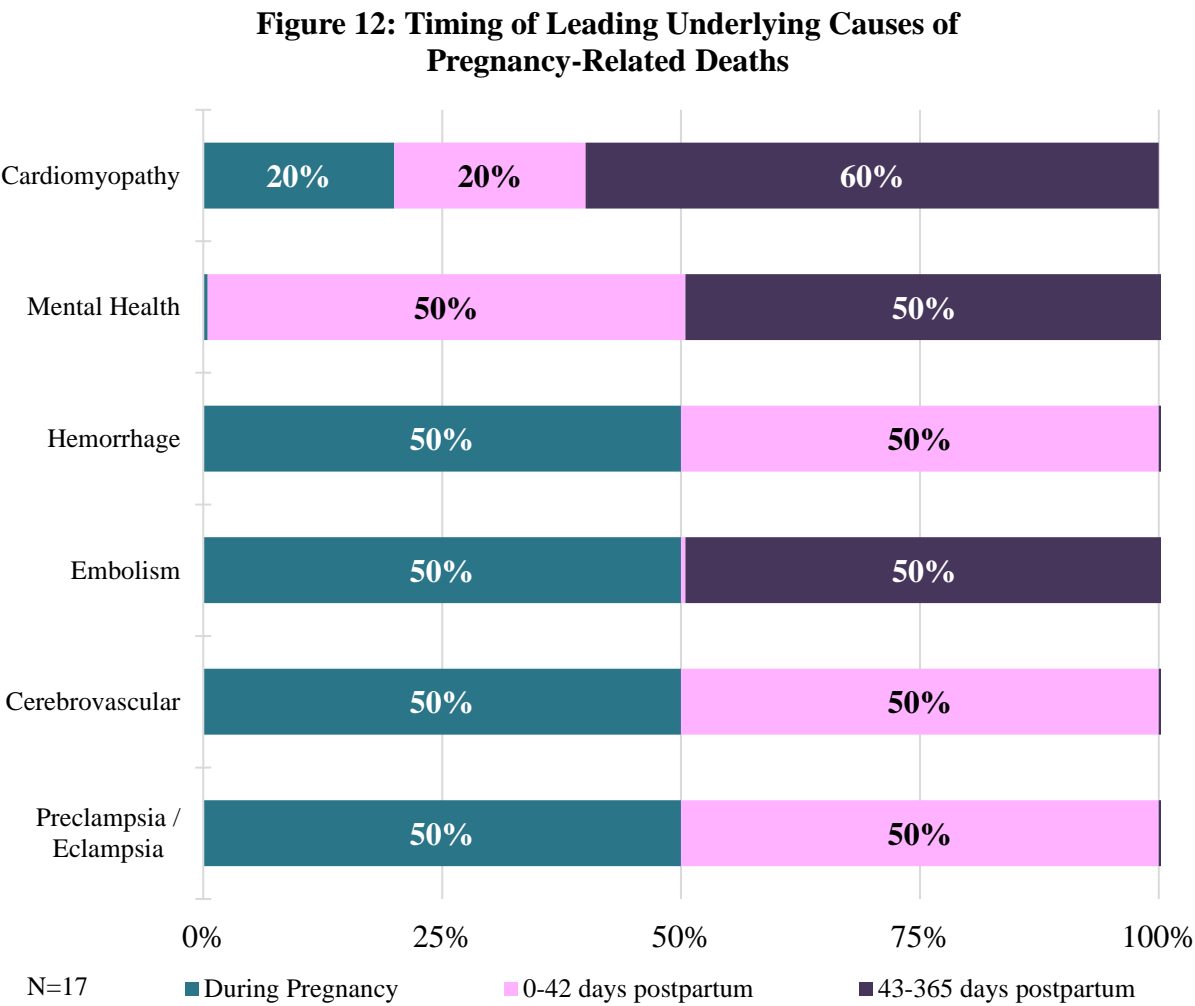
Cause and Context

Upon reviewing the information obtained, and determining pregnancy-relatedness, the PAMR board worked to establish a consensus between committee members regarding the underlying cause of death and as appropriate indicates a contributing cause of death for pregnancy-related cases. Cardiomyopathy, a medical condition which makes it more difficult for a person's heart to pump blood to the rest of their body, was the leading underlying cause of pregnancy-related deaths in 2017.¹⁹ Among injury-related deaths, the most frequent cause of death was MVC, followed by overdoses/poisonings.

Additional data were provided to help offer context for understanding the circumstances leading up to death. One of these data points was the timing of a death in relation to the pregnancy. In the period between 43 days and one year postpartum, there were more than four times as many pregnancy-associated deaths as there were pregnancy-related deaths. The board also looked for additional factors that contributed to deaths, specifically mental health conditions, substance use disorder, and obesity.

Causes of Death

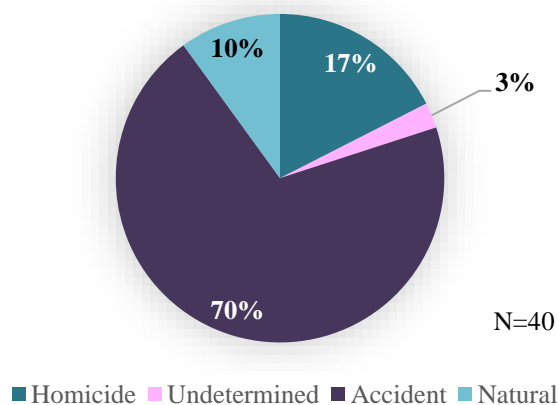
The PAMR board agreed upon an underlying cause of death for all cases determined to be pregnancy-related. *Overall*, cardiomyopathy was the most common cause of death for pregnancy-related cases. The most common cause of death for women *during pregnancy* in 2017 was preeclampsia/eclampsia. This was also the most common cause for Missouri women who were *0 to 42 days postpartum*. The most common cause of death for women who were *43 days to one year postpartum* was cardiomyopathy, followed by embolism (Fig. 12).



For nine of 19 pregnancy-related cases, the committee indicated a secondary contributing cause of death. Cardiomyopathy, including postpartum cardiomyopathy, was a secondary contributor in 22% of these cases. Other secondary causes included hemorrhage, chronic hypertension, hematologic disease, mental health conditions, unintentional injury, other neurological disease and other cardiovascular disease.

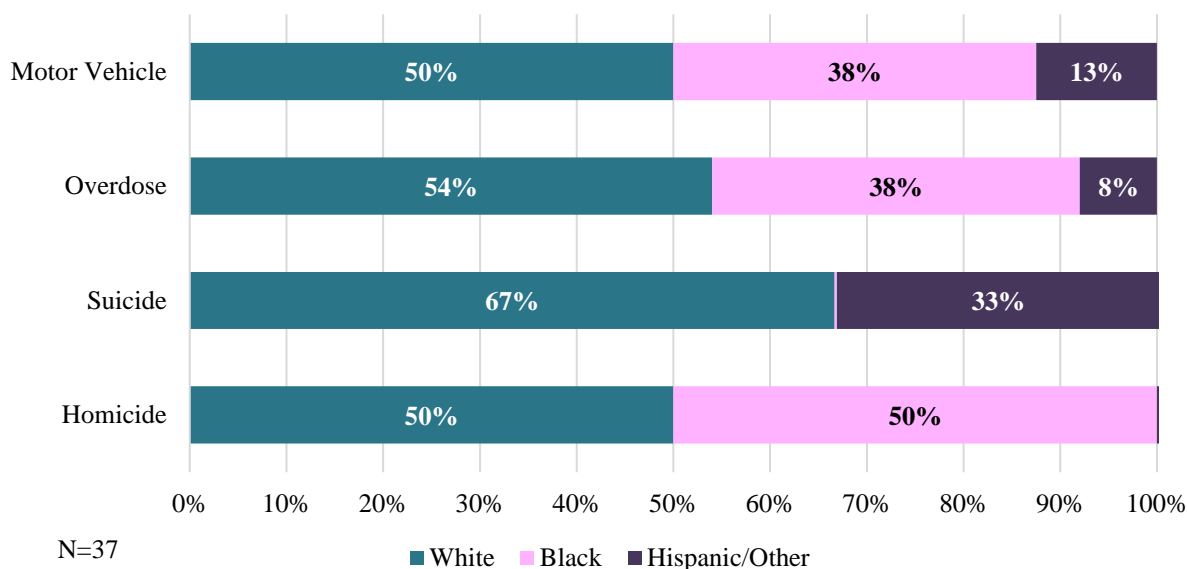
The underlying cause of death is determined for pregnancy-related deaths. To evaluate pregnancy-associated deaths the manner of death as found on the death certificates was utilized. The majority of pregnancy-associated, but not related, deaths were due to accidents (70%) (Fig. 13). Of these accidents, 54% were MVCs while 43% were overdose/poisoning deaths. In addition, more than three-quarters of homicide deaths were attributed to firearms.

Figure 13: Manner of Pregnancy-Associated Deaths



For the purposes of this report, those deaths which were not determined to be due to natural causes are here termed “injury-related”. Additional analysis of these deaths demonstrated racial disparities. While 15% of live births were to Black Missouri mothers, in 2017 they made up 50% of homicide, 38% of overdose, and 38% of MVC deaths (Fig. 14). These disparities were not as strongly pronounced for those who were Hispanic/Other. In this report, those cases that were determined to “Probably” be suicides were treated as suicides.

Figure 14: Injury-Related Death by Race



Deaths which the board determined were homicides comprised 15% of all verified deaths. In 50% of homicide cases, the relationship of the perpetrator was unknown, or determined not applicable. In 22% of homicides, the perpetrator had no relationship with the decedent, and in roughly 11% of cases the perpetrator was the decedent’s partner. Of those women whose deaths

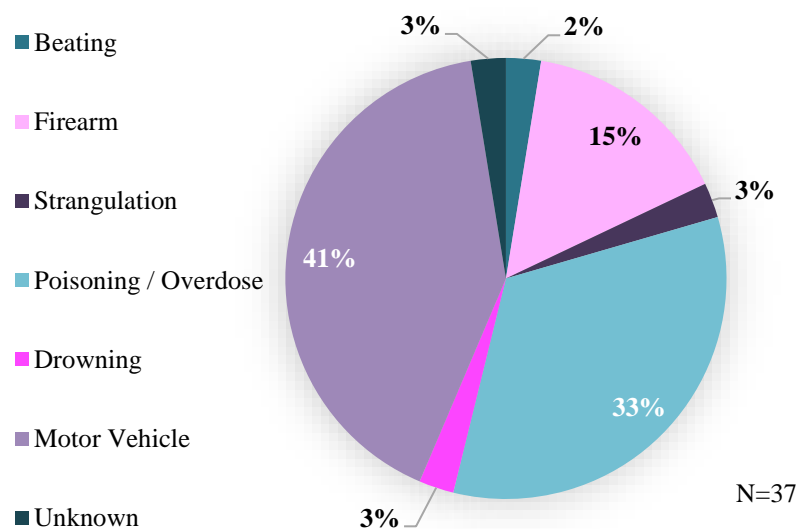
were ruled homicides, 44% had a history of substance use, while 11% had a history of domestic violence.

Due to the extremely low sample size of cases that were determined to be suicides by the PAMR board (2%), further demographic analysis of these instances was not reportable in accordance with best practices regarding messaging and suicide.²⁰ Cases which were ruled suicides were generally lacking socio-environmental data. This may not be the case in the future, as the number of cases available for analysis increases, but it is a restriction for the present year of data.

Deaths which were due to injury-related causes based upon the manner of death were evaluated by the board to determine the means of fatal injury (Fig. 15).

The largest proportion of injury-related verified deaths were MVCs (41%). This was followed by poisoning or overdose deaths (33%). The third largest category was firearm related deaths at roughly 15%.

Figure 15: Means of Injury, 2017



Regarding deaths which were not related to medical complications, such as homicides, suicides, MVCs and overdoses, the majority (63%) occurred between 43 days and one year postpartum. The means of injury data predominantly pertain to pregnancy-associated deaths (88%). However, this information helps provide context for 16% of pregnancy-related deaths as well.

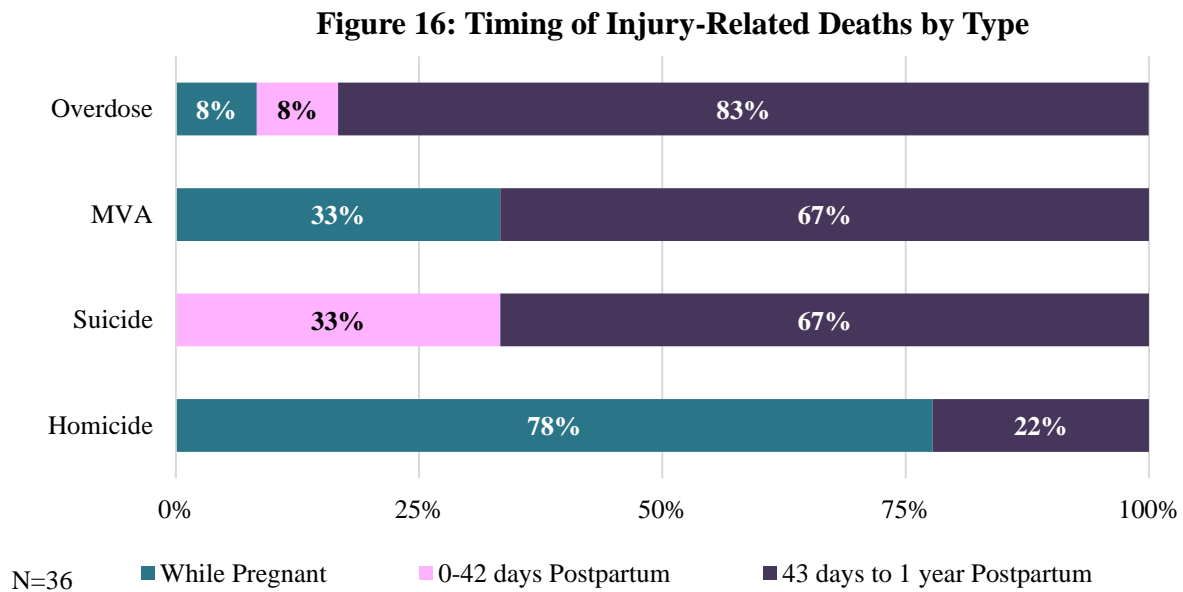


Figure 16 provides a graphic representation of when a given type of injury-related death occurred in relation to a pregnancy.

- The majority of overdose deaths (83%) were found to occur between 43 days and one year postpartum, while another 8% occurred both between zero and 42 days postpartum and during pregnancy.
 - Overdoses made up 45% of all deaths occurring between 43 days and one year postpartum.
- The majority of MVC's (67%) occurred between 43 days and one year postpartum while 33% occurred during pregnancy.
 - MVC's comprised 36% of all injury-related deaths occurring between 43 days to one year postpartum.
 - MVC's comprised 33% of all injury-related deaths occurring while pregnant.
 - In 85% of MVC deaths, the decedent was unrestrained (not including pedestrians hit by vehicles).
- The majority of homicides (78%) occurred during pregnancy, while 22% occurred between 43 days and one year postpartum.
 - Homicides comprised 9% of all injury-related deaths occurring between 43 days and one year postpartum.
 - Homicides comprised 58% of all injury-related deaths occurring while pregnant.
- The majority of suicides (67%) occurred between 43 days and one year postpartum while 33% occurred between 0 and 42 days postpartum.
 - Due to sample size limitations, information on suicides should be used cautiously.



Contributing Factors

In accordance with CDC best practice standards, the PAMR board evaluates three factors to determine whether they contributed to an instance of maternal mortality. Mental health conditions are the first factor evaluated. While instances of postpartum psychosis are extremely rare, postpartum depression affects 1 out of 7 mothers.²¹ Mental Health conditions were determined to be contributing factors in 27% of verified deaths which were considered injury-related.

SUD is the second factor evaluated. SUD is a recognized mental health disorder, and therefore a subset of mental health conditions. Given the increase in overdose-related deaths in MO, this remains an area of public health concern.²² SUD contributed to nearly half of those deaths determined to be from injury-related causes.

Maternal obesity is the final contributing factor evaluated by the PAMR board. Obesity continues to be a problem across the country and is a high risk factor for both maternal mortality and SMM. Obesity was only found to be a contributing factor in those deaths which were considered natural based upon the manner of death on the death certificate.

Mental Health Conditions

Overall, mental health conditions contributed to 27% of pregnancy-associated deaths, and 16% of pregnancy-related deaths.

- In 79% of deaths where a mental health condition was determined to be a contributing factor, the records also indicated that the decedent had a history of substance use.
- For 15% of pregnancy-associated deaths, the board was unable to definitively say if mental health conditions were a contributing factor (Fig. 17).
- Additionally:
 - Forty-three percent of these women had dealt with unemployment.
 - Forty-three percent had a history of psychiatric hospitalizations or treatment.
 - Forty-three percent had involvement with child protective services.
 - More than one-third (36%) of women for whom mental health conditions contributed to their deaths had a history of domestic violence.

Figure 17: Contribution of Mental Health Conditions, 2017

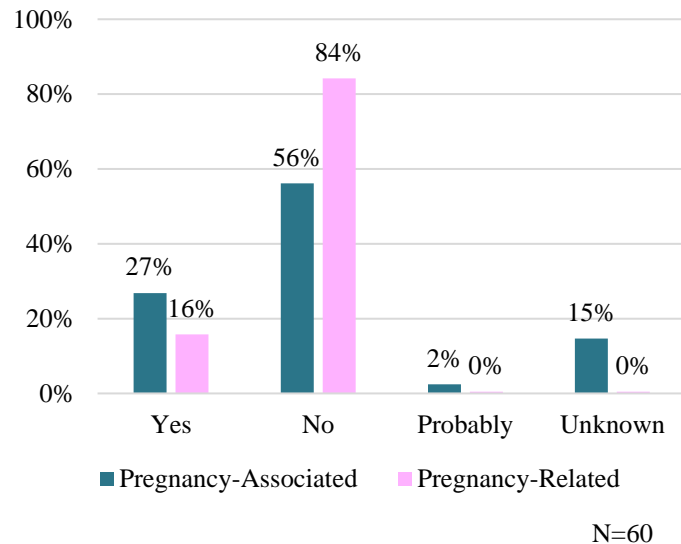
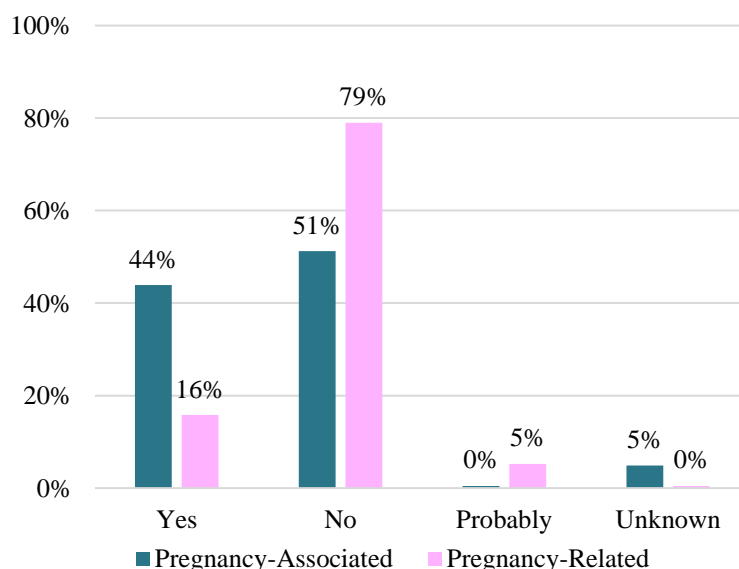


Figure 18: Contribution of Substance Use Disorder, 2017



Substance Use Disorder

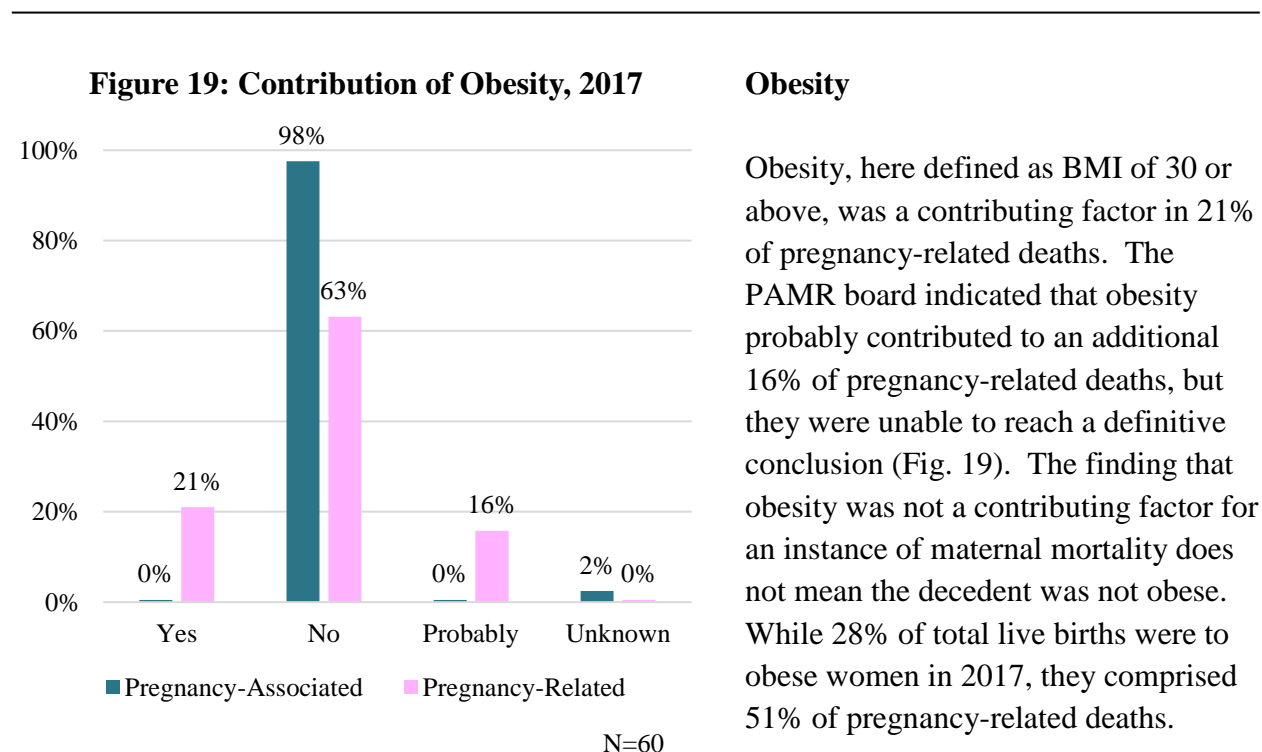
There were 951 fatal opioid overdoses in Missouri in 2017. This represents a 42% increase from 2015.

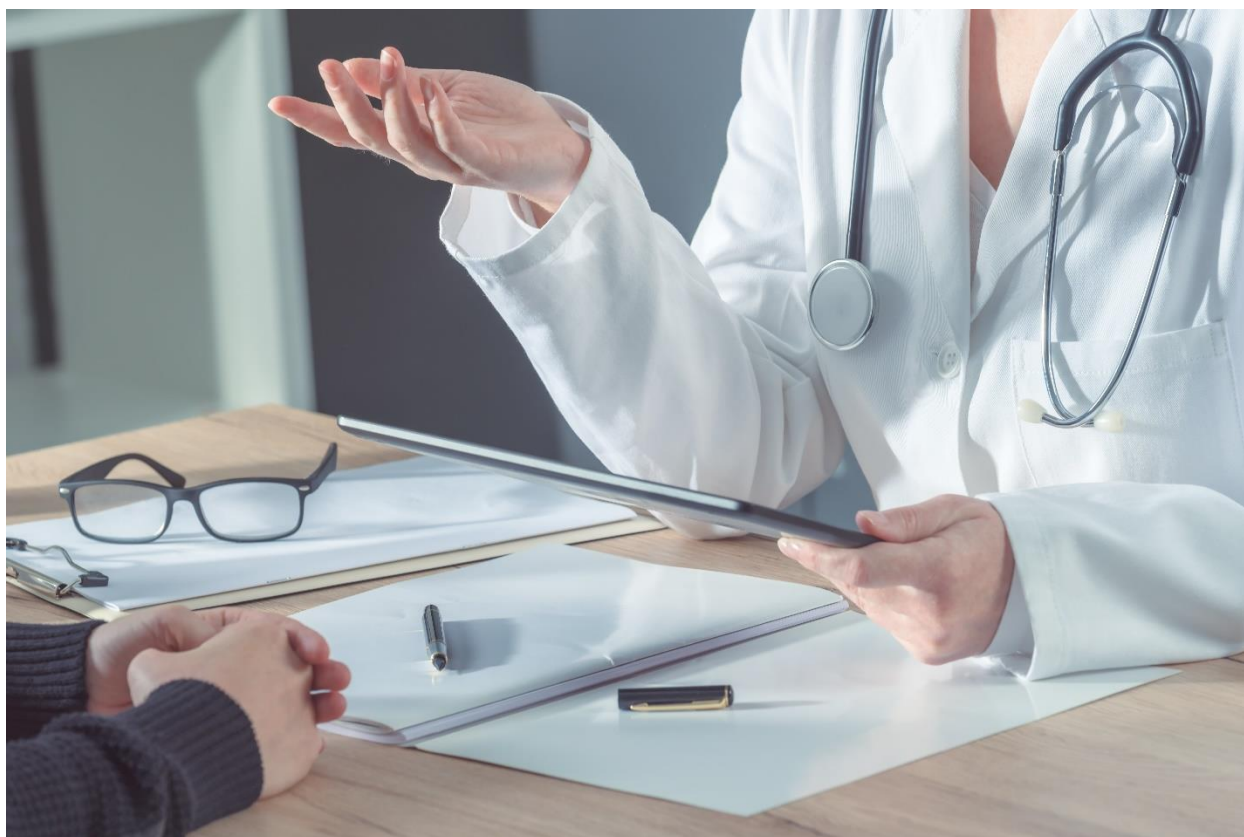
- The majority of opioid fatalities (74%) had a history of substance misuse, and
- Fourteen percent had experienced a previous overdose.²²

In 2017, SUDs (including opiates, alcohol and other substances) were a

contributing factor in 44% of pregnancy-associated and 16% of pregnancy-related deaths (Fig. 18).

- There was insufficient evidence for the PAMR board to definitively say whether SUDs were a contributing factor for 5% of pregnancy-related deaths, and 5% of pregnancy-associated deaths were unknown.
- More than half (57%) of those deaths where the board determined SUD was a contributing factor also listed mental health as a contributing factor.
- Thirty-eight percent had a history of psychiatric hospitalization or treatment.
- Of those for whom SUD was a contributing factor:
 - Thirty-eight percent had involvement with child protective services.
 - Twenty-nine percent had evidence of unemployment.
 - Twenty-four percent had a history of domestic violence.
 - Nineteen percent had a history of substance use treatment.





Preventability and Recommendations

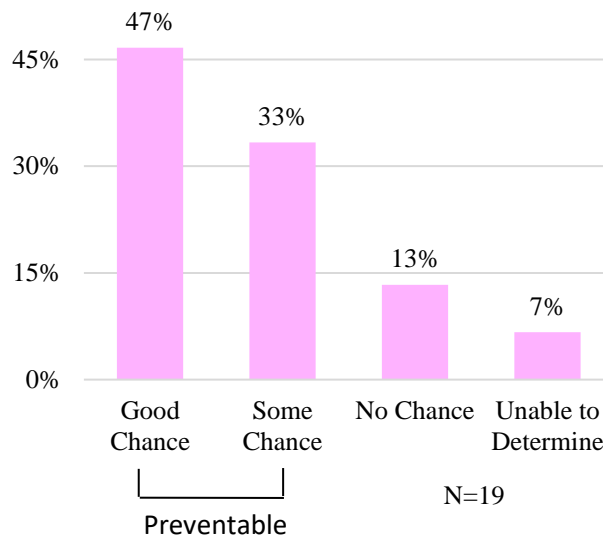
The PAMR board evaluated whether or not a death was preventable and the likelihood of altering the outcome. For preventable deaths, the board made recommendations about the specific and feasible actions that, if taken, might have changed the course of events. The board recommended interventions across five categories: patient/family, provider, facility, system, and community.

Two of the major recommendations were a campaign to increase patient education regarding seat belt safety and others concerning resource availability for mental health conditions and substance use disorders. The board further recommended standardization regarding practices and procedures across the entire healthcare system, and improvements to the continuity of care between systems. Increasing providers' education was also recommended, specifically regarding mental health, substance use, and diagnosis of cardiovascular disorders associated with pregnancy. Medicaid expansion to one year postpartum was also frequently recommended.

Preventability

A pregnancy-related death is considered to have been preventable if the committee determines that there was at least some chance of the death being averted by one or more reasonable changes^{††} to patient, family, provider, facility, system, and/or community factors. Among these deaths, the majority (80%) were considered preventable, while 20% were either non-preventable, or the committee felt that it could not determine preventability (Fig. 20).

Figure 20: Chance to Alter Outcome of Pregnancy-Related Deaths

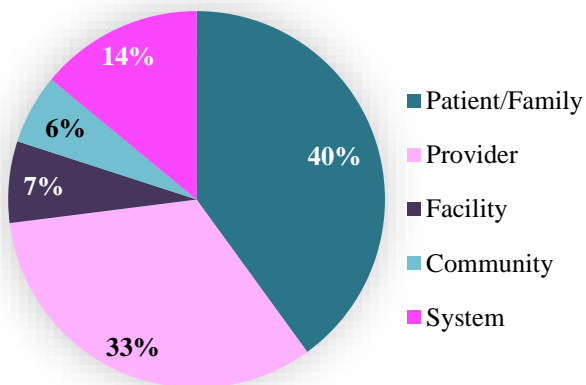


Recommendations: Category and Class

The ultimate goal of the PAMR program is to prevent future maternal deaths. To achieve this goal, the PAMR board identifies opportunities for prevention that could have altered the outcome. These interventions are grouped into five categories (Fig. 21). After categorization, they are then classified along common themes.

While the majority of the identified opportunities for prevention were categorized as

Figure 21: Opportunities for Intervention - Categories



patient/family (40%), these often interacted with other categories, as detailed below. The board determined that roughly one in three of the identified interventions fell within the provider category. The board works with de-identified information, which includes information pertaining to facilities and geographic areas. This privacy protection limits their ability to identify local community and facility specific opportunities for prevention. As such, interventions within these categories were based on what is anticipated to have a statewide impact.

^{††} The board exercised their judgment and applied the reasonable person standard in considering whether or not a change was reasonable.

Table 8: Overall Prevention Classifications					
	#	%		#	%
Adherence	23	12.4	Social Support/Isolation	5	2.7
Knowledge	21	11.4	Violence	5	2.7
Continuity of Care	19	10.3	Other	5	2.7
Clinical Skill/Quality of Care	17	9.2	Unstable Housing	4	2.2
Delay	13	7.0	Chronic Disease	4	2.2
Access/Financial	12	6.5	Outreach	4	2.2
Referral	10	5.4	Communication	3	1.6
Assessment	10	5.4	Law Enforcement	2	1.1
Substance Use Disorder	10	5.4	Cultural/Religious	1	0.5
Mental Health Conditions	9	4.9	Environmental	1	0.5
Policies/Procedures	7	3.9	Total	185	100.2

The opportunities for prevention were most frequently classified as *adherence* (12%). Adherence is the classification used when an identified issue was related to the provider or patient not following protocol or failing to comply with standard procedures. Opportunities were classified as gaps in *knowledge* when the board found that either the provider or the patient had an inadequate understanding of the significance of a health event, or they lacked understanding about the need for treatment/follow-up after evaluation for a health event (11%). Finally, instances related to a providers' ability to access a woman's complete records were classified as *continuity of care* issues (10%).

The factors contributing to a death do not take place in a vacuum and so may influence each other. A delay in seeking treatment may have been rooted in a gap in knowledge regarding a chronic disease. A woman may have begun using substances to deal with social isolation which compounded a mental health condition. Policies may be in place at some facilities that prevent providers from making some referrals, interrupting continuity of care by preventing communication across systems, or even conducting more comprehensive patient assessments. As such, implementation of a single recommendation at one level may have an effect on the others.

In addition to identifying themes using the category and classification, content analysis was performed on the recommendations to supplement these quantitative measures with qualitative data. There were four dominant themes which emerged through this process to help target efforts at decreasing maternal mortality. The most prominent theme was recommendations for standardization. This was followed by themes focused on enhancing education for both patients and providers. Additionally, the board recommended increasing services and knowledge for the treatment of mental health issues and SUD.

Table 9: Class of Recommendations for Patient/Family Category														
	Adherence	Substance Use Disorder	Knowledge	Delay	Mental Health Conditions	Social Support / Isolation	Access/Financial	Violence	Chronic Disease	Unstable Housing	Cultural/Religious	Environmental	Communication	TOTAL
#	23	10	9	9	6	5	3	2	2	2	1	1	1	74
%	31.1	13.5	12.2	12.2	8.1	6.8	4.1	2.7	2.7	2.7	1.4	1.4	1.4	100.3

Opportunities for prevention that were classified as adherence all connected to the patient category, and comprised nearly one third of all patient related recommendations. More specifically, the board recommended that a campaign to increase awareness of the importance of complying with seat belt regulations postpartum be undertaken. This was done because, upon review, the board found that a majority of motor-vehicle related deaths involved lack of seat belt use.

Opportunities for prevention involving recurrent use of alcohol and/or drugs causing clinically and functionally significant impairment, were classified as *substance use disorder*. All of the instances for intervention regarding SUD, were categorized as patient/family. However, the qualitative analysis demonstrated that SUD classified preventions were aimed at both patients and providers.

While it was recommended that patients be educated regarding the dangers and treatment options for SUD, the committee also recommended providers standardize screening, prescription, and treatment practices. Provider education regarding pain management was another recommendation that touched upon this classification. Based upon the content analysis, opportunities for prevention of this issue exist across categories. This is the kind of supplementary data that requires qualitative analysis to obtain.

Opportunities for prevention were classified as *delays* when the board determined there was a failure to seek care or follow-up action. This classification comprised 12% of all patient/family recommendations, the same frequency as those seeking to address a gap in knowledge. Delays were categorized as patient/family, as the board recognizes the burden of responsibility ultimately rests with the patient. However, here the board also recommended providers and facilities pursue missed follow-ups as standard practice. This was done to recognize that healthcare providers and systems can do more to ease the burden of responsibility from patients.

Opportunities for prevention that were classified as *mental health conditions* comprised roughly 8% of the patient/family recommendations. This includes perinatal mood and anxiety disorders like postpartum depression. The board recommended that knowledge regarding mental health resources be increased for both patients and providers. Additionally, they recommended increased opportunities for mental health screenings during the postpartum period, and expanded telehealth options for mental health care. Recommendations also included extending Medicaid to cover mental health conditions for up to one year postpartum.

Opportunities for prevention involving a lack of support from family, partners, or friends were classified as *social support/isolation*. This comprised nearly 7% of the patient/family recommendations. When the board determined a woman's physical or social environment contributed to her death, recommendations were classified as *environmental* (1%). When the board found that a woman's beliefs acted as a barrier to care due to lack of understanding, or led to refusal of therapy, the recommendation was classified as *cultural/religious*.

Provider

	Clinical Skill / Quality of Care	Knowledge	Assessment	Referral	Continuity of Care / Care Coordination	Delay	Other	Mental Health Conditions	Chronic Disease	Access / Financial	Policies / Procedures	Outreach	TOTAL
#	16	10	9	8	7	4	2	1	1	1	1	1	61
%	26.2	16.4	14.8	13.1	11.5	6.6	3.3	1.6	1.6	1.6	1.6	1.6	99.9

Opportunities for prevention where the board determined personnel were not appropriately skilled for the situation or failed to exercise clinical judgment consistent with current standards of care were classified as *clinical skill/quality of care*. This comprised more than one in four (26%) of the recommendations in the provider category. The board's recommendations sought to improve clinical care by addressing gaps in knowledge (16%). Specific recommendations by the board addressed the need for continued care of preexisting conditions, a need to perform echocardiograms for patients at high risk for peripartum cardiomyopathy, and screening recently pregnant women for hypertensive issues as standard practice.

Opportunities for prevention were classified as *assessment* when the board determined that the woman was placed at risk for a poor clinical outcome due to screening failures, and as a result she was not transferred/transported to a provider able to give a higher level of care (15%). Instances where the board determined that the appropriate specialists were not consulted or did

not provide care; or that referrals to specialists were not made were classified as *referral* (13%). While the board did recommend improved referrals to medical specialists, they also recommended referrals to social workers, and to mental health providers.

Facility

Table 11: Class of Recommendations for Facility Category						
	Policies / Procedures	Continuity of Care / Care Coordination	Mental Health Conditions	Communication	Clinical Skill / Quality of Care	TOTAL
#	6	4	1	1	1	13
%	46.2	30.8	7.7	7.7	7.7	100.1

Opportunities for prevention where the board found that the facility lacked basic policies or infrastructure suitable for the woman's needs were classified as *policies/procedures* (46%). The board's recommendations consistently recognized a need for standardization, across practices, procedures, and treatments. The previously discussed recommendations for follow-up care at the provider level were echoed at the facility level.

Opportunities for prevention classified as continuity of care comprised 31% of facility recommendations. Recommendations were classified as *communication* (8%) when the board determined that the health outcome may have been improved had care not been fragmented among or between healthcare facilities or healthcare units. Through the qualitative analysis, continuity of care between providers was also a theme, calling for increased standardization in communication of patient medical data within hospitals and between hospital systems. This will be addressed further at the system level.

Community

Table 12: Class of Recommendations for Community Category								
	Knowledge	Violence	Access / Financial	Outreach	Unstable Housing	Law Enforcement	Other	TOTAL
#	2	2	2	2	1	1	1	11
%	18.2	18.2	18.2	18.2	9.1	9.1	9.1	100.1

At the community level, recommendations were limited. The four leading classes were knowledge, violence, access/financial, and outreach at 18% each. Opportunities for prevention where physical or emotional abuse was perpetrated by current or former intimate partners, family members, or strangers were classified as *violence*.

Recommendations were classified as *access/financial* when system issues, e.g. lack or loss of healthcare insurance or other financial duress, as opposed to an issue with adherence, impacted a woman's ability to care for herself. This classification was also used to indicate other barriers to accessing care, such as insurance non-eligibility, provider shortage in a woman's location and lack of public transportation. Opportunities for prevention where the board found a lack of coordination between healthcare systems and other organizations in the area that work with maternal child health issues were classified as *outreach*.

During the qualitative analysis, a theme emerged which could be addressed at the community level. This was the need for increased preconception health education to provide knowledge on issues such as chronic medical conditions, obesity prevention, tobacco cessation, etc. Providers are restricted to those instances where a woman engages the health system, as are facilities. While the argument could be made that this is the patient/family responsibility, they can hardly be blamed for not knowing what they don't know. As such, community resources are uniquely situated to allow for the dissemination of information regarding the importance of preconception health to their target populations.

Table 13: Class of Recommendations for System Category

	Continuity of Care / Care Coordination	Access / Financial	Referral	Other	Violence	Mental Health Conditions	Chronic Disease	Unstable Housing	Communication	Outreach	Law Enforcement	Assessment	TOTAL
#	8	6	2	2	1	1	1	1	1	1	1	1	26
%	30.8	22.1	7.7	7.7	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	99.5

At the system level, conclusions which sought to address problems regarding the continuity of care made up the largest group (31%). System level recommendations are naturally ambitious as they seek to fix issues which hinder the entire health system. The recommendations for improving continuity of care at the system level included increased use of telehealth systems for referrals, and centralization of electronic medical records.

These recommendations were followed by concerns regarding a lack of access/financial resources at 22%. Roughly 8% of recommendations were classified as referrals and *other* factors. Opportunities for prevention where a woman was either homeless, living in a shelter, or living in temporary housing were classified as *unstable housing* (4%). Recommendations were classified as *law enforcement* (4%) when the board determined that law enforcement response was either not timely or was not appropriate or thorough in scope.

Opportunities for prevention where it was determined that the occurrence of one or more significant pre-existing medical conditions contributed to a woman's health outcome were classified as *chronic disease*. The recommendations for preconception health and patient education regarding chronic disease were repeated within the system category.

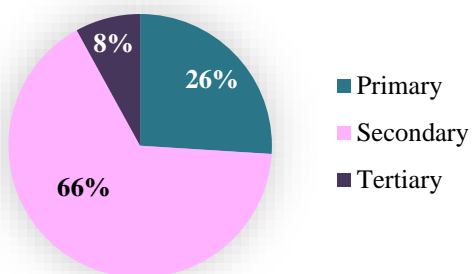
At the system level, the board urged extension of the Medicaid program. There were two major subthemes that emerged within these recommendations. First, the board recommended extension of the Medicaid program to cover women up to one year postpartum. Along with this was they recommended that Medicaid coverage include mental health care during and up to one year postpartum whether or not the patient was being treated for mental health conditions prior to delivery. Another theme that appeared at the system level was the need for increased telehealth options to address broader rural/urban disparities regarding provider coverage.

Within the database entry system that was utilized for the 2017 instances of maternal mortality, there were issues found regarding proper mapping. A number of recommendations applied to

more than one category or classification. The information presented is accurate as the system allowed the abstractor to correctly indicate the categories, classifications, prevention levels and impact that applied. However, it did not allow multi-response linkage between these variables and a specific recommendation. The content analysis performed aided in overcoming this issue which was found and addressed part of the way through the PAMR board reviewing 2018 cases, and more direct evaluations may be able to be made beginning with the 2019 data. See Appendix C for action items developed from the board recommendations.

Recommendations: Prevention and Impact

Figure 22: Prevention Level



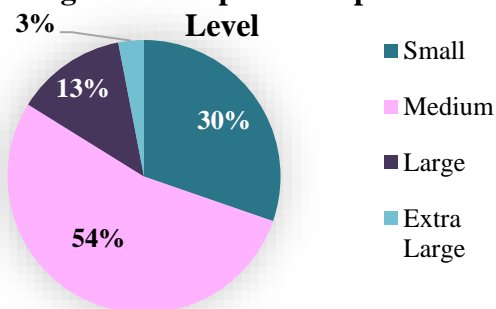
Recommendations at the primary level of prevention were those that prevent the contributing factor before it ever occurs. Primary recommendations comprised 26% of recommendations. The majority of ranked recommendations (66%) were directed at the secondary level of prevention. These were those recommendations targeted at reducing the impact of the contributing factor once it has occurred. Lastly, tertiary level prevention comprised 8% of the recommendations

(Fig. 22). These were recommendations that would reduce the impact of the progression of what has become an ongoing contributing factor.

The expected impact of a recommendation was ranked from small to giant. Small impacts, those involving education/counseling (community- and/or provider-based health promotion and education activities) were expected from 30% of recommendations. The majority of recommendations (54%) were anticipated to have a medium impact. These involved clinical interventions and coordination of care across the continuum of well-

woman visits (protocols, prescriptions). Large impacts, those that act as long-lasting protective interventions (improve readiness, recognition and response to obstetric emergencies/long-acting reversible contraceptives) were anticipated for 13% of recommendations. Extra-large impacts, those that create a change in context (promoting environments that support healthy living/ensure available and accessible services) were anticipated for 3% of recommendations (Fig. 23). There were no giant impacts expected from the committee recommendations. This impact level was reserved for those recommendations which address social determinants of health (poverty, inequality, etc.). Given this finding, the board resolved to better capture the influences of the social determinants of health and make recommendations targeted at addressing these in the future.

Figure 23: Expected Impact Level





Conclusions

Maternal mortality in the state of Missouri is exceptionally complex. It touches the societal issues of rampant obesity, health inequity, and the ongoing opioid epidemic. Seeking to understand this problem brings to light a variety of other concerns rooted in the healthcare system, provider education, patient accountability, and community failings. Through addressing the issues identified by the PAMR board, the state of Missouri will be able to decrease our rate of maternal mortality, while simultaneously improving those situations related to this issue. It is with this goal in mind that the PAMR board recommended standardization regarding the practices and procedures within the healthcare system, as well as improvements to the continuity of care abilities within and between systems. The board also found a demonstrated need for increases in education of both providers and patients regarding treatment during and after pregnancy; and the expansion of options for healthcare, including mental health. And the board further concluded that community organizations could be utilized to help women understand the importance of maintaining good health prior to conception. Moving forward, the PAMR board will continue to review cases of maternal mortality and provide recommendations to eliminate preventable maternal mortality in the future.

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Appendix A: Detailed Case Identification Criteria

PAMR coordinates with the BEVS to accurately identify eligible pregnancy-associated deaths for review. All death certificates of Missouri residents (including those residents who died out of state) between the ages of 12 and 55 in 2017 were considered a potential case if:

1. The underlying cause of death is coded with an International Classification of Diseases (ICD-10) code. If the code indicates that the cause of death was due to pregnancy, it will identify the case. These codes are:
 - a. A34.
 - b. O00-O99.
 - c. More information on these ICD-10 codes can be found here:
https://www.cdc.gov/nchs/data/dvs/2e_volume1_2017.pdf.
2. Linkage to a birth certificate or fetal death report within one year prior to date of death using the following criteria:
 - a. Matched based on Social Security Number.
 - b. Matched based on mothers first and last name.
 - c. Matched based on common misspellings and transposed names.
 - d. Matched based on mothers date of birth and name.
3. Completion of the pregnancy checkbox on the death certificate to indicate the decedent either was pregnant at the time of death, or had been pregnant within the last year.

Appendix B: Sources of Mortality Review Outline

National Sources of Maternal Mortality Information				
	Missouri Vital Statistics (MVS)	NCHS (2003-2017) / WHO	PMSS	MMRC (PAMR)
Data Sources	Death Certificates	Death Certificates	Death Certificates linked to fetal death and birth certificates	Death certificates lined to fetal death and birth certificates, medical records, social service records, informant interviews, social media etc.
Time Frame	During Pregnancy – 1 year	During Pregnancy – 42 days	During Pregnancy – 1 year	During Pregnancy – 1 year
Inclusion	Missouri Residents	Missouri Residents	Missouri Recorded	Missouri Residents
Source of Classification	ICD-10 codes	ICD-10 codes	Medical epidemiologists (PMSS-MM)	Multidisciplinary committee
Terms	Maternal Death	Maternal Death	Pregnancy-Associated, Pregnancy-Related	Pregnancy-Associated, Pregnancy-Related
Measure	Maternal Mortality Rate - # of Maternal Deaths per 100,000 live births	Maternal Mortality Rate - # of Maternal Deaths per 100,000 live births	Pregnancy-Related Mortality Ratio - # of Pregnancy-Related Deaths per 100,000 live births	Pregnancy-Related Mortality Ratio - # of Pregnancy-Related Deaths per 100,000 live births
Purpose	Show state trends and provide a basis for national comparison	Show national trends and provide a basis for international comparison	Analyze clinical factors associated with deaths, publish information that may lead to prevention strategies	Understand medical and non-medical contributors to deaths, prioritize interventions that effectively reduce maternal deaths.

Appendix C: Action Items

Upon completion of case reviews, a subset of the PAMR board met to discuss the provided recommendations. This allowed for the development of specifically targeted action items for the improvement of maternal health that the PAMR program will work to implement during the current year. The five established action items are:

1. In order to enhance provider knowledge, the program will work with partners to develop a social media campaign, supplemented with other media to disseminate information to women's health providers regarding board identified health concerns during the perinatal period.
2. American College of Obstetricians and Gynecologists (ACOG) standard of care guidelines regarding hypertension, cardiomyopathy and other board identified concerns to be distributed to Ob/gyn's using established platforms.
3. In order to enhance surveillance of maternal mortality in the state of Missouri, the board will work to better capture information pertaining to the social determinants of health.
4. The department will work with partners to develop a perinatal seat belt safety campaign for dissemination targeted at women of childbearing age.
5. Information regarding the board's recommendation to extend Medicaid coverage for all maternal conditions (including medical, mental health, substance abuse treatment) to include one year postpartum, even if the woman did not start treatment until after pregnancy will be provided to partners and state legislature.